Survival and recolonisation following wildfire at Moyston West, Western Victoria. 2. Herpetofauna

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Abstract
Wildfire is a common occurrence in south-eastern Australia and affects fauna populations in various ways. In fragmented landscapes severe wildfire may lead to local extinction of some species; however, in other cases natural features such as cracks in the soil may provide refuges and the opportunity for some taxa to survive and recolonise surrounding areas. There is a lack of studies that provide both pre-wildfire and post-wildfire data on reptiles and amphibians especially at inland woodland sites. Data were collected to determine the presence and relative abundance of vertebrate fauna at a site near Moyston in Western Victoria on three occasions pre-wildfire and on seven occasions post-wildfire. Ten reptile and five amphibian species were recorded pre-wildfire, whilst 11 reptile and eight amphibian species were recorded post-wildfire. Bibron's Toadlet *Pseudophryne bibronii*, a species listed as threatened in Victoria, survived the wildfire in significant numbers in parts of the property severely burnt by wildfire. Several other species were recorded post-wildfire in sections of the property that were severely burnt. Numerous species appear to have survived the wildfire due to their ability to shelter underground, whilst others may have sheltered under large logs that were only partially burnt. Populations of other species may have survived due to a combination of breeding cycles, low metabolic rates and time of fire. At least one species of reptile may have recolonised the property from unburnt areas in neighbouring districts. (*The Victorian Naturalist* **131** (1) 2014, 4–14)

Keywords: wildfire, inland woodlands, refuges, reptiles, amphibians

Introduction

Numerous wildfires have burnt large parts of south-eastern Australia since European settlement over 200 years ago. The intensity of fire and condition of local environments produces a range of effects on reptiles and amphibians (Friend 1993). Several studies have been conducted into the status of reptile and amphibian populations following wildfire in Australia (Mather 1979; Lunney *et al.* 1991; Bamford 1992; Sass and Wilson 2006; Clemann 2009; Clemann and Antrobus 2010; Clemann *et al.* 2010; Howard *et al.* 2011; Howard *et al.* 2012). Penman and Towerton (2007) reported on the response of Verreaux's Tree Frog *Litoria verreauxii verreauxii* to a prescribed burn. Other studies have examined the effects on reptiles of experimental, low-intensity controlled fires (Trainor and Woinarski 1994; Masters 1996; Woinarski *et al.* 1999; Singh *et al.* 2002; Driscoll and Henderson 2008). Few studies, however, provide both pre-wildfire and post-wildfire data on reptiles or amphibians (Howard *et al.* 2010; Gillespie and West 2012). Without such information, land managers cannot know the true effects of fire and cannot make informed decisions on the management of wildlife populations. This paper aims to provide evidence from a woodland site in western Victoria on how reptiles and amphibians are able to survive wildfire. It follows other similar data from this location relating to the ability of mamals to survive wildfire (Homan 2012a).

Site Description

Wuurak is a 150 ha Land for Wildlife property situated 7 km west of Moyston (37° 18' S, 142° 41' E) and approximately 210 km west of Melbourne. A study to determine the presence and relative abundance of vertebrate fauna commenced at the property in October 2004 (Homan 2012a). Four Ecological Vegetation Classes (EVCs) are represented at Wuurak: Heathy Woodland, Sand Forest, Plains Grassy Woodland and Damp Sands Herb-rich Woodland (Fig. 1; DSE 2004; Homan 2012a). Gilgai is a soil formation where the land surface develops a pattern of depressions and mounds of various sizes. This condition arises as a result of alternate wetting and drying of clay soils and also produces deep cracks that can penetrate to well

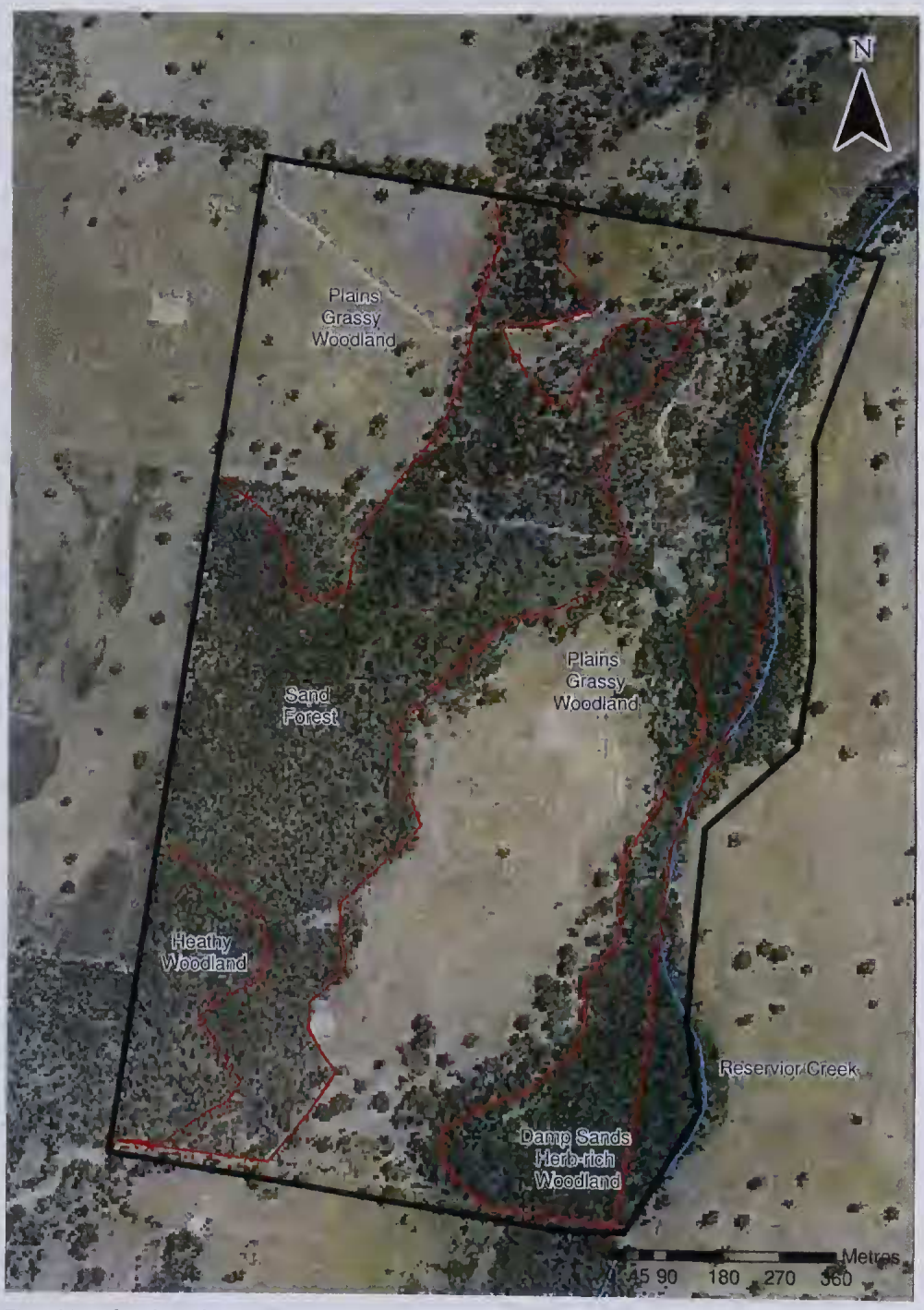

Fig.1. Map of Ecological Vegetation Classes at Wuurak Land for Wildlife property.

over 1 m (McKenzie *et al.* 2004). At Wuurak, gilgai was present in sections of Plains Grassy Woodland adjacent to Damp Sands Herb-rich Woodland along Reservoir Creek.

In December 2005 and January 2006, a severe wildfire (known as the Mt Lubra Fire) burnt 46% of the Grampians National Park and adjoining areas in western Victoria, especially around the Moyston district (Fig. 2). Wuurak was severely impacted by the wildfire; most of the property was severely burnt (all layers of vegetation including tree canopies and most fallen logs destroyed), whilst much smaller areas were either moderately burnt (tree canopies unburnt and many large logs only partially burnt) or lightly burnt (tree canopies unburnt with tree trunks lightly scorched and logs only lightly burnt). Two very small areas remained unburnt; an area of approximately 1 ha of Plains Grassy Woodland around farm buildings and a plant nursery; and an area of approximately 0.5 ha around a natural spring at the southern end of Reservoir Creek. The fire edge extended to approximately 30 km south, 20 km north, 25 km west and 5 km east of the property.

Methods

Several techniques were employed specifically to detect the presence of reptiles and amphibians (Homan 2012a; Table 1). These were funnel trapping, post-fire only (Ecosystematica Environmental Consultants, WA), artificial refuges, post-fire only (standard roof tiles, 410 x 245 mm), pitfall trapping, active searching (rock, log and debris turning; scanning possible reptile basking sites with binoculars) and aural amphibian survey (calling male frogs). One pitfall line consisting of ten 20 L plastic buckets was established on a sand-dune in Heathy Woodland. Buckets were 5 m apart and a 300 mm high aluminium flywire drift fence stretched for 60 m. Two lines of funnel traps were established in Damp Sands Herb-rich Woodland; the first was established 35 months post-fire and the second 82 months post-fire. Each line consisted of 20 funnel traps set 5 m apart in pairs, one on each

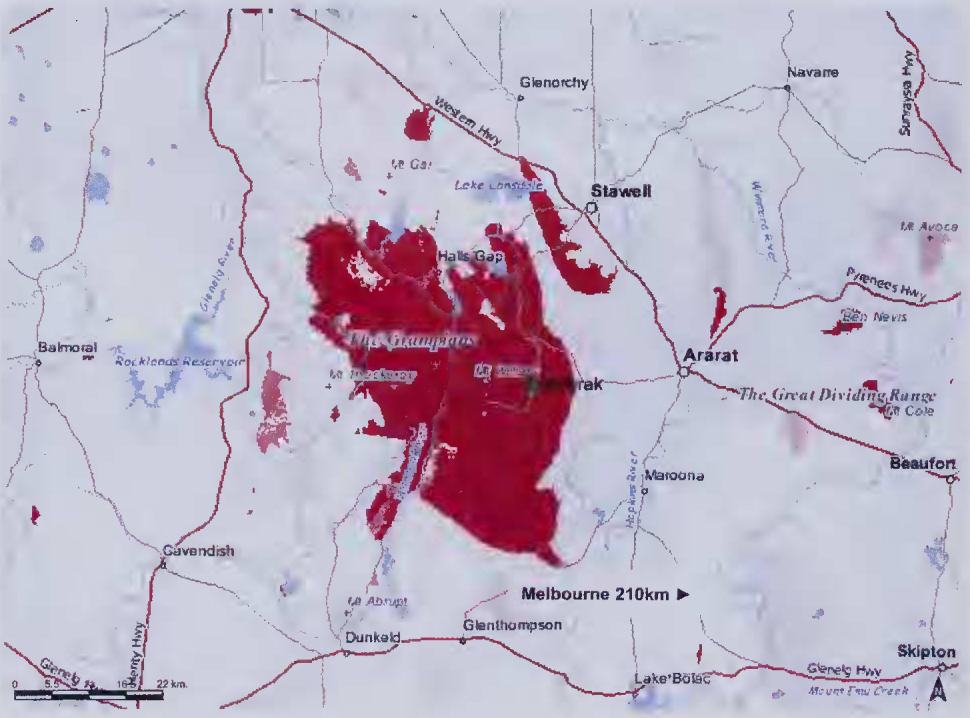

Fig. 2. Map showing extent of Mt Lubra wildfire December 2005/January 2006.

Table 1. Survey methods and effort completed pre-wildfire and post-wildfire for each Ecological Vegetation Class (EVC) at Wuurak in western Victoria. HW = Heathy Woodland; DSHRW = Damp Sands Herb-rich Woodland; PGW = Plains Grassy Woodland; SF = Sand Forest. Pitfall, Funnel, Cage and Elliott = trap-nights (Cage and Elliott daylight sampling only); ASH = active search hours; AAS. = aural amphibian survey, minutes; Roof Tiles = number laid.

		Survey Method						
EVC		**Pitfall**	**Funnel**	**Cage**	**Elliott**	**ASH**	**AAS**	**Roof Tiles**
HW	Pre-fire	60				2		
	Post-fire	110				2		
DSHRW	Pre-fire			200	60	5	60	
	Post-fire		120		90	12	120	
PGW	Pre-fire					2	60	
	Post-fire					6	120	25
SF	Pre-fire					2		
	Post-fire					2		20

side of a 300 mm high aluminium flywire drift fence that stretched for 60 m. Standard roof tiles were laid in two locations on the property; one month post-fire 20 tiles were laid in a line in pairs 1 m apart, with 5 m between each pair in an area of badly degraded Sand Forest that was severely burnt. A grid of 25 standard roof tiles was established 59 months post-fire in an area of Plains Grassy Woodland that was moderately burnt. The grid contained five lines with five tiles on each line. Lines and tiles were spaced at 5 m.

The study sites were surveyed on three occasions before wildfire (October 2004, November 2004 and March 2005) and on seven occasions after wildfire (December 2008, April 2010, December 2010, March 2011, April 2012, November 2012 and March 2013). Overall, 640 trap-nights were completed—320 pre-fire and 320 post-fire; active searching was conducted for 33 hours—11 pre-fire and 22 post-fire; aural amphibian survey was conducted for 360 minutes—120 pre-fire and 240 post-fire. Roof tiles in degraded Sand Forest were checked once during each visit post-fire; roof tiles in Plains Grassy Woodland were checked once during each visit after December 2010 (Table 1). Common and scientific names and taxonomy follow the Victorian Biodiversity Atlas, except for Bibron's Toadlet *Pseudophryne bibronii* which follows Tyler and Knight (2009).

Results

Pre-wildfire

One gecko, five skinks, two dragons and two elapid snakes were recorded pre-wildfire (Table 2). One hylid frog and four myobatrachid frogs were recorded pre-wildfire (Table 3). Amphibians included Bibron's Toadlet *Pseudophryne bibronii* (also known as Brown Toadlet) (Fig. 3), a species listed as threatened in Victoria (DSE 2013). One individual was captured in a pitfall trap in Heathy Woodland, and males were heard calling in significant numbers in Plains Grassy Woodland.

Post-wildfire

One gecko, six skinks, two dragons and two elapid snakes were recorded post-wildfire (Table 2). One hylid frog and seven myobatrachid frogs were recorded post-wildfire (Table 3). Bibron's Toadlet was recorded in several areas that were severely burnt. Individuals were captured in pitfall traps in Heathy Woodland, large numbers were heard calling in Plains Grassy Woodland and one individual was found under a roof tile in degraded Sand Forest.

Discussion

There is a lack of published information on the effects of fire on reptiles and amphibians, especially at inland woodland sites (Friend 2004). Available data, however, suggest that many reptiles and amphibians may be more resilient to the immediate effects of fire than mammals, due in part to their ability to construct burrows or shelter underground (Bamford 1992; Friend 1993). Many reptiles that inhabit dry places or areas with soft soils construct burrows (Heatwole and Taylor 1987; Cogger 2000). At sites with hard soils, many small reptiles will use deep cracks in the ground or burrows constructed by other taxa, such as spiders or

Table 2. Reptiles recorded in each Ecological Vegetation Class (EVC) at Wuurak, Western Victoria, before and after wildfire in January 2006. Key: EVC = Ecological Vegetation Class; DSHRW = Damp Sands Herb-rich Woodland; HW = Heathy Woodland; SF = Sand Forest; PGW = Plains Grassy Woodland; E = estimated number.

		Pre-wildfire			Post-wildfire						
Species	**EVC**	10/04	11/04	3/05	12/08	4/10	12/10	3/11	4/12	11/12	3/13
Months pre- and post-wildfire		-15	-14	-10	+35	+51	+59	+62	+75	+82	+86
Marbled Gecko *Christinus marmoratus*	PGW		1			1	1	1		1	2
Eastern Three-lined Skink *Acritoscincus duperreyi*	PGW		1				1				
	DSHRW			1	1						
Large Striped Skink *Ctenotus robustus*	HW										1
Garden Skink *Lampropholis guichenoti*	HW		3	1			1				2
	DSHRW				30E						
	PGW									1	
Bougainville's Skink *Lerista bougainvillii*	HW		6	1							
	SF					2		1		2	
Common Blue-tongued Lizard *Tiliqua scincoides*	DSHRW		1								
	SF								1		
Stumpy-tailed Lizard *Tiliqua rugosa*	DSHRW		3			1					
	HW						1				
Tree Dragon *Amphibolurus muricatus*	HW			3				2			2
	PGW					1					
	SF									1	
Bearded Dragon *Pogona barbata*	SF		1							1	1
Tiger Snake *Notechis scutatus*	DSHRW			1	1					1	
	PGW										1
Little Whip Snake *Parasuta flagellum*	SF					2		3	1	3	4
Eastern Brown Snake *Pseudonaja textilis*	HW		1								

Table 3. Amphibians recorded in each Ecological Vegetation Class (EVC) at Wuurak, Western Victoria, before and after wildfire in January 2006. DSHRW = Damp Sands Herb-rich Woodland; HW = Heathy Woodland; SF = Sand Forest; PGW = Plains Grassy Woodland. E = estimated number.

				Pre-wildfire		Post-wildfire					
Species	**EVC**	10/04	11/04	3/05	12/08	4/10	12/10	3/11	4/12	11/12	3/13
Months pre- and post-wildfire		-15	-14	-10	+35	+51	+59	+62	+75	+82	+86
Southern Brown Tree Frog *Litoria ewingii*	DSHRW		3E			5E	5E	2			
	PGW							3			1
Common Froglet *Crinia signifera*	DSHRW	2	5E		10E	30E	10E	5E	5E	8	
	PGW									1	1
Plains Froglet *Crinia parinsignifera*	DSHRW				5E		5E				
	PGW										1
Southern Bullfrog *Limnodynastes dumerilii*	DSHRW				5E						
	HW		1	2			16	6			7
	PGW									1	
	SF										1
Striped Marsh Frog *Limnodynastes peronii*	DSHRW						5E				
Spotted Marsh Frog *Limnodynastes tasmaniensis*	DSHRW				5E	5E					
Geocrinia sp.	DSHRW			1							
Southern Smooth Froglet *Geocrinia laevis*	DSHRW					3					
Bibron's Toadlet *Pseudophryne bibronii*	PGW			20E		30E		60E			
	HW			1		1	2	2			2
	SF							1			

yabbies, for shelter (Clemann 2000; Sass and Wilson 2006). Numerous myobatrachid frogs have adaptations that allow them to burrow in soil during times of inactivity, with some species remaining underground for long periods (Tyler 1989). Some of the reptiles and amphibians recorded at Wuurak share these aspects of life history.

Few studies provide data on the ability of amphibian populations to survive wildfire. Howard *et al.* (2011) conducted amphibian surveys at two sites north-east of Marysville in Victoria, one which was severely burnt by wildfire and one which was only moderately burnt. At both sites, good populations of Common Froglets were detected nine months post-wildfire. Gillespie and West (2012) assessed the status of Spotted Tree Frog *Litoria spenceri* populations in the Taponga River catchment in north-east Victoria following wildfire. Initial results of the study indicated that the wildfire did not appear to have an adverse impact on Spotted Tree Frogs.

At Wuurak more amphibian species and individuals were recorded post-fire, which is certainly due, partly, to increased effort, but also may be due to the breaking of the drought in 2010. Amphibian activity is greatly influenced by rainfall and most records of calling male frogs and captures in pitfall traps and funnel traps were obtained during or around rain events. Other factors can affect amphibian surveys. Ten months pre-fire, one *Geocrinia* sp. was found on the ground by chance at night, but could not be identified to species level. Two species of this genus are known from Victoria: the Victorian Smooth Froglet *Geocrinia victoriana* has a wide distribution throughout southern and central Victoria, whilst the Southern Smooth Froglet *Geocrinia laevis* has a more restricted distribution, being found mostly in the south-west of the state (Hero *et al.* 1991). The ranges of the two species rarely overlap; however, both have been recorded in the eastern Grampians region (Gollmann 1991). Both species have similar body markings and can be readily identified only by their different advertisement calls. At no time pre- or post-fire were calls of Victorian Smooth Froglets heard at Wuurak. Fifty-one months post-fire the distinctive calls of male Southern Smooth Froglets were heard at night in an area of Damp Sands Herb-rich Woodland that was severely burnt. This visit to the property coincided with rainfall, during the restricted calling time for males of this species.

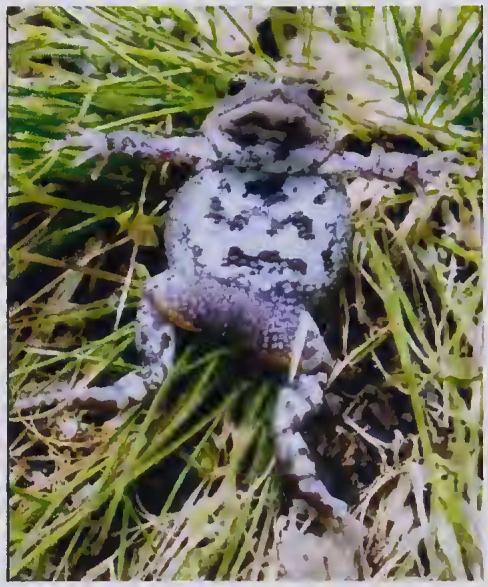

Fig. 3. Bibron's Toadlet *Pseudophryne bibronii*. Photo by Peter Homan.

The survival of amphibians at Wuurak may be due to several factors including the presence of suitable refuges and soil type and structure. It is probable that the population of Bibron's Toadlets in the Plains Grassy Woodland section of the property survived the wildfire by sheltering in deep cracks that were present in gilgai depressions. Along Reservoir Creek and in the Heathy Woodland/Sand Forest sections of the property the deep sandy soils provided ideal places for Bibron's Toadlet and other burrowing species, such as Southern Bullfrog, to seek refuge. There is a lack of studies investigating Bibron's Toadlet populations following wildfire. Howard *et al.* (2010) assessed the status of Bibron's Toadlet and Southern Toadlet *Pseudophryne semimarmorata* 12 months post-wildfire at over 100 sites in the Kinglake area and surrounding districts. Bibron's Toadlet was detected in very small numbers and only from relatively undisturbed habitats in unburnt areas; however, historical data indicated a decline

Fig. 4. Large River Red Gum log that survived wildfire near Reservoir Creek. Photo by Peter Homan.

in the population of the species throughout the study area for many years pre-wildfire.

Other amphibian species may have survived wildfire at Wuurak by using cracks in the ground or by sheltering under large River Red Gum *Eucalyptus camaldulensis* logs (Fig. 4) that survived in Plains Grassy Woodland adjacent to Reservoir Creek, and then recolonising nearby areas. The Southern Brown Tree Frog, Common Froglet, Plains Froglet, Southern Smooth Froglet, Spotted Marsh Frog and Striped Marsh Frog often shelter under logs during times of inactivity (Homan pers. obs.).

The survival of reptiles at Wuurak may be due to several factors including breeding cycles combined with time of fire, low metabolism, attenuated body shape, burrowing habits and the ability to shelter under and inside large logs. The Garden Skink, an egg layer, breeds in spring, with births taking place in late summer (Joss and Minard 1985). Eggs are laid, often communally under rocks, logs or other hard terrestrial structure (Homan pers. obs.). The eggs of Garden Skinks would have been deposited under various logs throughout the property at the time of the fire. Some adult Garden Skinks may have sheltered under large logs or used cracks in the ground to escape the fire. The small size and attenuated body shape are conducive to the species using such refugia. Some individuals may have used yabby holes along Reservoir Creek or sheltered underground in the damp sands in this part of the property. Significant numbers of Garden Skinks were detected 35 months post-fire amongst dense thickets of regenerating Swamp Gum *Eucalyptus ovata* in Damp Sands Herb-rich Woodland along Reservoir Creek. One individual was captured in an Elliott trap that was left open for daylight sampling. Interestingly, no Garden Skinks were recorded in this EVC pre-fire or again at any other time post-fire, despite considerable time spent in this part of the property conducting a range of vertebrate survey techniques. In the Heathy Woodland/Sand Forest section (Fig. 5) Garden Skinks may have survived by sheltering in the deep sandy soil. Lunney *et al.* (1991) found Garden Skinks present in all habitats during studies up to 48 months following intense fire, with greater numbers in gullies than

Fig. 5. Regenerating Heathy Woodland. Photo by Adam Merrick.

on ridges. Penn *et al.* (2003) found a significant increase in Garden Skink numbers 20 months after a low-intensity, hazard reduction fire. Lunney *et al.* (1991) suggested that survival of Garden Skink can be attributed to its ability to take refuge underground.

Bougainville's Skink (Fig. 6), a fossorial species with an attenuated body shape (Cogger 2000), most probably would have sheltered in the sandy soil in Heathy Woodland and Sand Forest, thus surviving wildfire in these parts of the property. The Eastern Three-lined Skink, Stumpy-tailed Lizard, Common Blue-tongued Lizard and Tiger Snake may have recolonised other parts of the property after sheltering under or inside large River Red Gum logs that were only partially burnt in Plains Grassy Woodland.

Female Tree Dragons construct a burrow in which eggs are laid in late spring, with young hatching and leaving burrows in late summer (Harlow and Taylor 2000). Tree Dragon eggs would have been deposited underground in nesting burrows when the fire swept through the property in early January. Despite this, there is no doubt that mortality amongst adult Tree Dragons may have been high due to the severity of the fire and the partially arboreal habits of the species. A very small population survived in the unburnt area around farm buildings mentioned above. In areas where fire intensity is low, arboreal dragons have survived wildfire by climbing into the unburnt canopies of large trees (Griffiths and Christian 1996); however, in the Heathy Woodland/Sand Forest areas of Wuurak, the canopies of virtually all eucalypts were burnt. Minimal data exist on the effects of wildfire on Tree Dragon populations. Clemann *et al.* (2010) conducted surveys of threatened herpetofauna north of Dargo in Victoria 12 months post-wildfire. During this study, Tree Dragons were seen basking on fallen timber beside tracks in areas that were burnt by wildfire. Whilst the Tree Dragon was recorded at Wuurak relatively quickly post-fire, the Bearded Dragon was not recorded until 82 months post-fire. Before the fire, this species was often seen by the landowners. Bearded Dragons may not have survived wildfire at Wuurak and most likely recolonised the property from the east where unburnt habitat was 5 km away.

Fig. 6. Bougainville's Skink *Lerista bougainvillii*. Photo by Peter Homan.

The only records of Little Whip Snakes were obtained from under roof tiles post-fire from an area of severely degraded Sand Forest. This small, nocturnal elapid snake readily uses artificial refuges (Homan 2012b). The location where Little Whip Snake was recorded was severely burnt and was adjacent to a large area of Plains Grassy Woodland with cracking clay soils. When tiles were checked, several individuals escaped down holes and cracks that were present in the sandy loam soil. Little Whip Snakes almost certainly survived wildfire by sheltering in soil cracks and other ground refuges that were readily available in this part of the property.

Overall, results of herpetofauna surveys at Wuurak provide further evidence that, due to a number of life history, reproduction and environmental factors, many species of reptiles and amphibians are able to survive wildfire. These factors include the ability to shelter underground or to use other refugia and breeding cycles that include the construction of nesting burrows.

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References

Bamford MJ (1992) The impact of fire and increasing time after fire upon *Heleioporus eyrei*, *Limnodynastes dorsalis* and *Myobatrachus gouldii* (Anura: Leptodactylidae) in *Banksia* Woodland near Perth, Western Australia. *Wildlife Research* **19**, 169–178.

Clemann N (2000) The Swamp Skink *Egernia coventryi*: a Review of the Biology and Status. *Monitor* **11**, 13–15.

Clemann N (2009) The impact on threatened Victorian alpine herpetofauna of recent wildfires. Second Report. A report to the Statewide Services Division, Department of Sustainability and Environment. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment, Heidelberg, Victoria.

Clemann N and Antrobus J (2010) The status of the threatened Alpine Bog Skink *Pseudemoia cryodroma* after the Black Saturday fires at Lake Mountain and Mount Bullfight Nature Conservation Reserve. Department of Sustainability and Environment, Heidelberg, Victoria.

Clemann N, Howard K and Scroggie M (2010) The status of threatened herpetofauna after the Black Saturday fires in the Dargo-White Timber Spur Area: report on the first season's field surveys. Department of Sustainability and Environment, Heidelberg, Victoria.

Cogger H (2000) *Reptiles and Amphibians of Australia*. 6 edn. (Reed Books: Chatswood, NSW)

Driscoll DA and Henderson MK (2008) How many common reptile species are fire specialists? A replicated natural experiment highlights the predictive weakness of a fire succession model. *Biological Conservation* **141**, 460–471.

DSE (2004) EVC Benchmarks – Greater Grampians bioregion. (Department of Sustainability and Environment: Melbourne)

DSE (2013) *Flora and Fauna Guarantee Act 1988* – Threatened List, June 2013. Department of Sustainability and Environment, East Melbourne.

Friend GR (1993) Impact of fire on small vertebrates in mallee woodlands and heathlands in temperate Australia: a review. *Biological Conservation* **65**, 99–114.

Friend G (2004) Fire impacts on fauna. *The Victorian Naturalist* **121**, 116–121.

Gillespie GR and West M (2012) Evaluation of impacts of bushfire on the Spotted Tree Frog *Litoria spenceri* in the Taponga River Catchment, Northeast Victoria: Black Saturday Victoria 2009 – Natural values fire recovery program. Department of Sustainability and Environment, East Melbourne, Victoria.

Gollmann G (1991) Population structure of Australian Frogs (*Geocrinia laevis* Complex) in a Hybrid Zone. *Copeia* **3**, 593–602.

Griffiths AD and Christian KA (1996) The effects of fire on the frillneck lizard (*Chlamydosaurus kingii*) in northern Australia. *Australian Journal of Ecology* **21**, 386–398.

Harlow PS and Taylor JE (2000) Reproductive ecology of the jacky dragon (*Amphibolurus muricatus*): an agamid lizard with temperature-dependent sex determination. *Austral Ecology* **25**, 640–652.

Heatwole HF and Taylor J (1987) *Ecology of Reptiles*. (Surrey Beatty & Sons: Chipping Norton, NSW)

Hero JM, Littlejohn M and Marantelli G (1991) *Frogwatch field guide to Victorian frogs*. (Department of Conservation and Environment: East Melbourne)

Homan P (2012a) Survival and recolonisation following wildfire at Moyston West, Western Victoria: I. Mammals. *The Victorian Naturalist* **129**, 192–202.

Homan P (2012b) The use of artificial habitat during surveys of small, terrestrial vertebrates at three sites in Victoria. *The Victorian Naturalist* **129**, 128–137.

Howard K, Cleeland C and Clemann N (2010) Assessment of the status of the threatened Bibron's Toadlet and Southern Toadlet in areas affected by the Kilmore East-Murrindindi fires: Black Saturday Victoria 2009 – Natural values fire recovery program. Department of Sustainability and Environment, Heidelberg, Victoria.

Howard KM, Antrobus J and Clemann N (2011) A tale of two mountains: fire, fungus and Alpine Tree Frogs. *The Victorian Naturalist* **128**, 260–265.

Howard K, Clemann N and Antrobus J (2012) Assessment of the status of threatened herpetofauna following fire in sub-alpine habitat at Lake Mountain and Mount Bullfight, near Marysville, north-east Victoria. Department of Sustainability and Environment, Heidelberg, Victoria.

Joss JMP and Minard JA (1985) On the reproductive cycles of *Lampropholis guichenoti* and *L. delicata* (Squamata: Scincidae) in the Sydney region. *Australian Journal of Zoology* **33**, 699–704.

Lunney D, Eby P and O'Connell M (1991) Effects of logging, fire and drought on three species of lizards in Mumbulla State Forest on the south coast of New South Wales. *Australian Journal of Ecology* **16**, 33–46.

Masters P (1996) The effects of fire-driven succession on reptiles in Spinifex Grasslands at Uluru National Park, Northern Territory. *Wildlife Research* **23**, 39–48.

Mather PB (1979) An examination of the reptile fauna of Wyperfeld National Park using Pitfall Trapping. *The Victorian Naturalist* **96**, 98–101.

McKenzie N, Jacquier D, Isbell R and Brown K (2004) *Australian Soils and Landscapes: an illustrated compendium*. (CSIRO Publishing: Collingwood, Victoria)

Penman T and Towerton A (2007) Observations of responses to a prescribed burn in the frog *Litoria verreauxii* (Dumeril, 1853). *Herpetofauna* **37**, 83–84.

Penn AM, Sherwin WB, Lunney D and Banks PB (2003) The effects of a low-intensity fire on small mammals and lizards in a logged, burnt forest. *Wildlife Research* **30**, 477–486.

Sass S and Wilson A (2006) Effects of fire on lizard communities in the mallee shrublands of western New South Wales. *Herpetofauna* **36**, 106–111.

Singh S, Smyth AK and Blomberg SP (2002) Effect of a control burn on lizards and their structural environment in a eucalypt open-forest. *Wildlife Research* **29**, 447–454.

Trainor CR and Woinarski JCZ (1994) Responses of lizards to three experiments fires in the savanna forests of Kakadu National Park. *Wildlife Research* **21**, 131–147.

Tyler M (1989) *Australian frogs: a natural history*. (Reed New Holland: Sydney)

Tyler MJ and Knight F (2009) *Field guide to the frogs of Australia*. (CSIRO Publishing: Collingwood)

Woinarski JCZ, Brock C, Fisher A, Milne D and Oliver B (1999) Response of birds and reptiles to fire regimes on pastoral land in the Victoria River district, Northern Territory. *The Rangeland Journal* **12**, 24–38.

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